FINAL SUPPLEMENTAL ENVIRONMENTAL ASSESSMENT

Issuance of Marine Mammal Incidental Take Authorizations
to the California Department of Transportation to Take Marine Mammals
by Harassment Incidental to the Demolition of Pier E3
of the East Span of the Original San Francisco-Oakland Bay Bridge
in San Francisco Bay, California

September 2015

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LOCATION: San Francisco Bay, California

ABSTRACT: The National Marine Fisheries Service proposes to issue a Marine Mammal Incidental Take Authorization to the California Department of Transportation for the taking, by Level B harassment, of small numbers of marine mammals incidental to the demolition of Pier E3 of the East Span of the original San Francisco-Oakland Bay Bridge in San Francisco Bay, California.

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CHAPTER 1 DESCRIPTION AND PURPOSE AND NEED

1.1 DESCRIPTION OF PROPOSED ACTION

On March 3, 2015, the California Department of Transportation (CALTRANS) submitted a request to the National Marine Fisheries Service (NMFS) for the potential harassment of small numbers of marine mammals incidental to the dismantling of Pier E3 of the East Span of the original San Francisco-Oakland Bay Bridge (SFOBB) in San Francisco Bay (SFB), California, in fall 2015. CALTRANS is proposing a Demonstration Project to remove the Pier E3 via highly controlled implosion with detonations. On April 16, 2015, CALTRANS submitted a revision of its request with an inclusion of a test implosion before the bridge demolition.

In response to a receipt of a request from CALTRANS, NMFS proposes to issue an Incidental Harassment Authorization (IHA) that authorizes takes by level B harassment of marine mammals incidental to the CALTRANS' proposed SFOBB Pier E3 demolition project, pursuant to section 101(a)(5)(D) of the Marine Mammal Protection Act of 1972, as amended (MMPA; 16 U.S.C. §§ 1631 *et seq*.), and the regulations governing the taking and importing of marine mammals (50 Code of Federal Regulations (CFR) Part 216).

This Final Supplemental Environmental Assessment (Final SEA), titled "*Issuance of Marine Mammal Incidental Take Authorizations to the California Department of Transportation to Take Marine Mammals by Harassment Incidental to the Demolition of Pier E3 of the East Span of the Original San Francisco-Oakland Bay Bridge in San Francisco Bay, California*," (hereinafter, Final SEA) addresses the potential environmental impacts of two alternatives, namely:

- Issue an Authorization to CALTRANS under the MMPA for Level B harassment of marine mammals for its proposed Pier E3 demolition project via controlled implosion, taking into account the prescribed means of take, mitigation measures, and monitoring requirements required in the proposed Authorization; or

- Not issue an Authorization to CALTRANS, in which case, for the purposes of NEPA analysis only, we assume that CALTRANS would forego the proposed Pier E3 demolition project via controlled implosion in the San Francisco Bay.

1.1.1 BACKGROUND ON CALTRANS' MMPA APPLICATION

On September 14, 2001, NMFS received a request from CALTRANS requesting IHAs for the taking, by Level B harassment, of small numbers of marine mammals incidental to construction of a replacement bridge for the East Span of the SFOBB, in SFB, California. The first IHA was issued to CALTRANS for this activity on November 10, 2003 (68 FR 64595; November 14, 2003), with subsequent IHAs issued on the following dates:

- January 3, 2005 (70 FR 2123, January 12, 2005),
- April 30, 2006 (71 FR 26750; May 8, 2006),
- May 2, 2007 (72 FR 25748; May 7, 2007),
- August 14, 2009 (74 FR 41684; August 18, 2009),
- February 7, 2011 (76 FR 7156; February 9, 2011),

- January 7, 2013 (78 FR 2371; January 11, 2013),
- January 8, 2014 (79 FR 2421; January 14, 2014), and
- July 15, 2015 (80 FR 43710, July 23, 2015).

NMFS actions of the issuance of these IHAs were analyzed in *San Francisco-Oakland Bay Bridge East Span Seismic Safety Project Final Environmental Impact Statement* (FEIS) prepared by the Federal Highway Administration (FHWA) in 2001, the *Environmental Assessment on the Authorization for the Harassment of Marine Mammals Incidental to Construction of the East Span of the San Francisco-Oakland Bridge under Section 101(a)(5) of the Marine Mammal Protection Act* (2003 EA) prepared by NMFS in November 2003, and the *Supplemental Environmental Assessment on the Authorization for the Harassment of Marine Mammals to Construction of the East Span of the San Francisco-Oakland Bridge under Section 101(a)(5) of the Marine Mammal Protection Act* (2009 SEA) prepared by NMFS in July 2009.

These NEPA documents provide required environmental analyses for NMFS' issuance of IHAs to take marine mammals incidental to CALTRANS' SFOBB East Span bridge replacement construction via in-water pile driving (by impact and vibratory hammers), pile removal, and other mechanical methods. Controlled implosion with underwater detonation was not analyzed because it was not a proposed method by CALTRANS at the time.

On March 3, 2015, CALTRANS requested another IHA that would cover its take of small numbers of marine mammals by Level B harassment incidental to Pier E3 demolition using controlled implosion by detonation. A controlled implosion is proposed as an alternate to the originally-permitted mechanical methods of dismantling because it is expected to require fewer in-water work days, have fewer effects on aquatic resources of the San Francisco Bay, and require less time to complete.

1.1.2 Marine Mammals in the Action Area

CALTRANS has requested an authorization to take 4 marine mammal species by Level B harassment. These species are: Pacific harbor seal (*Phoca vitulina richardsi*), California sea lion (*Zalophus californianus*), northern elephant seals (*Mirounga angustirostris*), and harbor porpoise (*Phocoena phocoena*).

1.2 Purpose and Need

The MMPA prohibits "takes" of marine mammals, with a number of specific exceptions. The applicable exception in this case is an authorization for incidental take of marine mammals in section 101(a)(5)(D) of the MMPA.

Section 101(a)(5)(D) of the MMPA directs the Secretary of Commerce (Secretary) to authorize, upon request, the incidental, but not intentional, taking of small numbers of marine mammals of a species or population stock, by United States citizens who engage in a specified activity (other than commercial fishing) within a specified geographical region if we make certain findings and provide a notice of a proposed authorization to the public for review. Entities seeking to obtain authorization for the incidental take of marine mammals under our jurisdiction must submit such a request (in the form of an application) to us.

We have issued regulations to implement the Incidental Take Authorization provisions of the MMPA (50 CFR Part 216) and have produced Office of Management and Budget (OMB)-approved application instructions (OMB Number 0648-0151) that prescribe the procedures necessary to apply for authorizations. All applicants must comply with the regulations at 50 CFR § 216.104 and submit applications requesting incidental take according to the provisions of the MMPA.

Purpose: The primary purpose of our proposed action—the issuance of an Authorization to CALTRANS—is to authorize (pursuant to the MMPA) the take of marine mammals incidental to CALTRANS' proposed activities. The IHA, if issued, would exempt CALTRANS from the take prohibitions contained in the MMPA.

To authorize the take of small numbers of marine mammals in accordance with Section 101(a)(5)(D) of the MMPA, we must evaluate the best available scientific information and determine the take would have a negligible impact on marine mammals or stocks and not have an unmitigable adverse impact on the availability of affected marine mammal species for certain subsistence uses. We cannot issue an IHA unless we can make these determinations.

In addition, we must prescribe, where applicable, the permissible methods of taking and other means of effecting the least practicable impact on the species or stocks of marine mammals and their habitat (i.e., mitigation), paying particular attention to rookeries, mating grounds, and other areas of similar significance. If appropriate, we must prescribe means of effecting the least practicable impact on the availability of the species or stocks of marine mammals for subsistence uses. Authorizations must also include requirements or conditions pertaining to the monitoring and reporting of such taking. Also, we must publish a notice of a proposed Authorization in the *Federal Register* for public notice and comment.

Need: On April 16, 2015, CALTRANS submitted an adequate and complete application demonstrating both the need and potential eligibility for issuance of an IHA in connection with the activities described in section 1.1.1. We now have a corresponding duty to determine whether and how we can authorize take by Level B harassments incidental to the activities described in CALTRANS' application. Our responsibilities under section 101(a)(5)(D) of the MMPA and its implementing regulations establish and frame the need for this proposed action.

Any alternatives considered under NEPA must meet the agency's statutory and regulatory requirements. Our described purpose and need guide us in developing reasonable alternatives for consideration, including alternative means of mitigating potential adverse effects.

1.3 Environmental Review Process

NEPA compliance is necessary for all "major" federal actions with the potential to significantly affect the quality of the human environment. Major federal actions include activities fully or partially funded, regulated, conducted, authorized, or approved by a federal agency. Because our issuance of an Authorization would allow for the taking of marine mammals consistent with provisions under the MMPA and incidental to the applicant's activities, we consider this as a major federal action subject to NEPA.

Under the requirements of NAO 216-6 section 6.03(f)(2)(b) for incidental harassment authorizations, we prepared this 2015 Final SEA to determine whether the direct, indirect and cumulative impacts related to the issuance of an IHA for incidental take of marine mammals during the conduct for CALTRANS' Pier E3 demolition project using controlled implosion in the San Francisco Bay could be significant. If we deem the potential impacts to be not significant, this analysis, in combination with other analyses incorporated by reference, may support the issuance of the Finding of No Significant Impact (FONSI) for the proposed Authorization.

1.3.1 Laws, Regulations, or Other NEPA Analyses Influencing the SEA's Scope

We have based the scope of the proposed action and nature of the two alternatives considered in this Final SEA on the relevant requirements in section 101(a)(5)(D) of the MMPA. Thus, our authority under the MMPA bounds the scope of our alternatives. We conclude that this analysis—when combined with the analyses in the following documents—fully describes the impacts associated with the proposed bridge demolition using controlled implosion with mitigation and monitoring for marine mammals. After conducting a review of the information and analyses for sufficiency and adequacy, we incorporate by reference the relevant analyses on CALTRANS' proposed demolition activities as well as discussions of the affected environment and environmental consequences within the following documents, per 40 CFR §1502.21 and NAO 216-6 § 5.09(d):

- *Incidental Harassment Authorization Application: Activities Related to the Demolition of Pier E3 of the East Span of the Original San Francisco-Oakland Bay Bridge* (CALTRANS, 2015)
- *Supplemental Biological Resources Evaluation: San Francisco-Oakland Bay Bridge (SFOBB) Pier E3 Demonstration Project* (CALTRANS, 2014a).
- *Water Quality Study: San Francisco-Oakland Bay Bridge Pier E3 Demonstration Project* (CALTRANS, 2014b)
- *San Francisco-Oakland Bay Bridge East Span Seismic Safety Project Final Environmental Impact Statement* (FHWA, 2001)
- *Environmental Assessment on the Authorization for the Harassment of Marine Mammals Incidental to Construction of the East Span of the San Francisco-Oakland Bridge under Section 101(a)(5) of the Marine Mammal Protection Act* (NMFS, 2003)
- *Supplemental Environmental Assessment on the Authorization for the Harassment of Marine Mammals to Construction of the East Span of the San Francisco-Oakland Bridge under Section 101(a)(5) of the Marine Mammal Protection Act* (NMFS, 2009)
- *Estimation of Sediment Concentrations during Demolition and Implosion of Bridge Piers: East Span Oakland-San Francisco Bay Bridge (CA)* (WRECO, 2014)

MMPA APPLICATION AND NOTICE OF THE PROPOSED AUTHORIZATION

The CEQ regulations (40 CFR § 1502.25) encourage federal agencies to integrate NEPA's environmental review process with other environmental reviews. We rely substantially on the public process for developing proposed Authorizations and evaluating relevant environmental information and provide a meaningful opportunity for public participation as we develop corresponding EAs. We fully consider public comments received in response to our publication of the notice of proposed Authorization during the corresponding NEPA process.

We considered CALTRANS' proposed mitigation and monitoring measures and determined that they would help ensure that the bridge demolition using controlled implosion would effect the least practicable impact on marine mammals. These measures include establishing and monitoring exclusion zones within which marine mammals could be exposed to receive sound levels associated with injury.

Through the MMPA process, we preliminarily determined that, provided that CALTRANS implement the required mitigation and monitoring measures, the impact of the activities on marine mammals would be, at worst, a temporary modification in behavior of small numbers of certain species of marine mammals from the brief implosion.

1.3.2 SCOPE OF THE ENVIRONMENTAL ANALYSIS

Given the limited scope of the decision for which we are responsible (*i.e.*, issue an IHA including prescribed means of take, mitigation measures, and monitoring requirements, or not issue the IHA), this Final SEA provides focused information on the primary issues and impacts of environmental concern related specifically to our issuance of the IHA. Potential environmental impacts associated with the issuance of the IHA were analyzed in CALTRANS application. In summary, impacts associated with implosion are similar to those expected to occur from mechanical dismantling. The analysis concluded, however, that the cumulative area subject to Level B Behavioral Harassment would be much greater for mechanical removal compared to the implosion alternative in section 1.3.1.

Table 1. A comparison of the content of the NMFS 2003 EA, 2009 SEA and this Final SEA

Section	2015 Final SEA	2009 SEA	2003 EA
Purpose and Need for Action	The 2003 EA's purpose and need for action is incorporated by reference.	The 2003 EA's purpose and need for action is incorporated by reference.	The purpose and need is to ensure compliance with the MMPA and its implementing regulations in association with CALTRANS proposed SF-OBB construction work in San Francisco Bay, California.

Section	2015 Final SEA	2009 SEA	2003 EA
Alternatives	For the proposed IHA, CALTRANS is proposing a demonstration project to remove Pier E3 via highly controlled charges (Demonstration Project). Controlled implosion is proposed as an alternate method to the original permitted mechanical methods for dismantling Pier E3, as it is expected to result in fewer in-water work days, have fewer effects on aquatic resources of the Bay, and require a shorter time frame for completion. In the SEA, two new alternatives are addressed: Alternative 1: (Preferred Alternative of SEA): Issuance of an IHA that includes taking of marine mammals incidental to the use of controlled charges used to dismantle Pier E3, with required mitigation. Alternative 2: Not issuing an IHA that includes taking of marine mammals incidental to the use of controlled charges used to dismantle Pier E3.	For the proposed IHA renewal, CALTRANS stated that the deployment of an air bubble curtain would not be feasible for the temporary pile driving activities due to the complexity of the driving frames. The Preferred Alternative (Alternative 2) and Alternative 3 of the 2003 EA will not work for this action. In the SEA, two new alternatives are added: Alternative 5: (Preferred Alternative of SEA): Issuance of an IHA that also includes taking of marine mammals by vibratory pile driving, with required mitigation measures but not an air bubble curtain. Alternative 6: Issuance of an IHA that does not allow taking of marine mammals by vibratory pile driving, with required mitigation measures but not an air bubble curtain.	Four alternatives evaluated by the NMFS in the 2003 EA: Alternative 1: No Action Alternative, Alternative 2: (Preferred Alternative): Issuance of an IHA with required mitigation measure including installation of a redesigned air bubble curtain. Alternative 3: Issuance of an IHA with required mitigation measure including installation of a fabric barrier system with air bubble curtain. Alternative 4: Issuance of an IHA without implementation of mitigation measures.
Affected Environment	Since northern elephant seals were not addressed in the 2003 EA and 2009 SEA, information on this species was added because NMFS thinks it could be affected as a result of the proposed CALTRANS SFOBB Pier E3 demolition activities.	Since harbor porpoises were not addressed in the 2003 EA, information on this species was added because NMFS thinks it could be affected as a result of the proposed CALTRANS SFOBB construction activities.	A detailed description of California sea lions, harbor seals, and eastern Pacific gray whales in the San Francisco Bay area were provided in detail in NMFS' 2003 EA. The non-marine mammal environment in the proposed action area was incorporated by reference from the FHWA FEIS.
Environmental Impacts (Including Cumulative Impacts)	Additional analyses are conducted to include effect of the proposed use of controlled charged to dismantle Pier E3 on marine mammals.	Additional analyses are conducted to include effect of proposed vibratory pile driving on marine mammals, including harbor porpoises, and the impacts of the proposed project on harbor porpoises.	The cumulative impacts were incorporated by reference from the FHWA FEIS
Mitigation	Additional analyses are conducted on mitigation measures for controlled implosion	Since the deployment of air bubble curtain would not be feasible for the proposed driving of temporary piles, this mitigation measure is not required. However, CALTRANS is required to perform acoustic measurement to establish the same 180 and 190 safety/buffer zones as required in the 2003 EA. Soft start is required for vibratory pile driving.	Mitigation measures in the 2003 EA included (1) establishment of safety/buffer zones, (2) compliance with equipment noise standards, (3) soft start, and (4) implementation of the air bubble curtain.

Section	2015 Final SEA	2009 SEA	2003 EA
Monitoring and Reporting	Additional analyses are conducted on monitoring measures for controlled implosion. NMFS 2003 EA was incorporated by reference regarding reporting requirements.	NMFS 2003 EA was incorporated by reference regarding the monitoring and reporting requirements.	CALTRANS is required to conduct visual observations before and during pile driving activities. Acoustical observation was required to establish the 180- and 190-dB safety zones. CALTRANS is required to submit monthly report during pile driving activities. A final report is required within 90 days after the expiration of the IHA.

1.3.3 COMMENTS ON APPLICATION AND SEA

NAO 216-6 established NOAA procedures for complying with NEPA and the implementing NEPA regulations issued by the CEQ. Consistent with the intent of NEPA and the clear direction in NAO 216-6 to involve the public in NEPA decision-making, we released a draft 2015 SEA for public comment on the potential environmental impacts of our issuance of an IHA, as well as comment on the activities described in CALTRANS' MMPA applications and in the *Federal Register* notice (80 FR 44060; July 24, 2015) of the proposed IHA. The CEQ regulations further encourage agencies to integrate the NEPA review process with review under other environmental statutes. Consistent with agency practice, we integrated our NEPA review and preparation of the Draft 2015 SEA with the public process required by the MMPA for the proposed issuance of the IHAs.

The Draft 2015 SEA and *Federal Register* notice (80 FR 44060; July 24, 2015) of the proposed IHA, combined with our preliminary determination, supporting analyses, and corresponding public comment period provided the public with information on relevant environmental issues and offered the public a meaningful opportunity to provide comments to us for consideration in both the MMPA and NEPA. During the public comment period, the NMFS received one comment letter from the Marine Mammal Commission (Commission). The Commission concurs with NMFS preliminary finding and recommends that NMFS issue the requested incidental harassment authorization, subject to inclusion of the proposed mitigation, monitoring, and reporting measures.

1.4 OTHER PERMITS, LICENSES, OR CONSULTATION REQUIREMENTS

Information regarding federal, state, and local permits, licenses, approvals, and consultation requirements necessary to implement the proposed action is incorporated by reference from NMFS 2003 EA and the FHWA 2001 FEIS. This information includes NEPA, MMPA, ESA, and the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA).

Chapter 2 Alternatives

2.1 Introduction

NEPA and the CEQ implementing regulations (40 CFR §§ 1500-1508) require consideration of alternatives to proposed major federal actions and NAO 216-6 provides NOAA policy and guidance on the consideration of alternatives to our proposed action. An EA must consider all reasonable alternatives, including the Preferred Alternative. It must also consider the No Action Alternative, even if it that alternative does not meet the stated purpose and need. This provides a baseline analysis against which we can compare the other alternatives.

To warrant detailed evaluation as a reasonable alternative, an alternative must meet our purpose and need. In this case, as we previously explained in Chapter 1 of this Final SEA, an alternative only meets the purpose and need if it satisfies the requirements under section 101(a)(5)(D) the MMPA. We evaluated each potential alternative against these criteria; identified one action alternative along with the No Action Alternative; and carried these forward for evaluation in this EA. This chapter describes the alternatives and compares them in terms of their environmental impacts and their achievement of objectives.

As described in Section 1.2, the MMPA requires that we must prescribe the means of effecting the least practicable impact on the species or stocks of marine mammals and their habitat. In order to do so, we must consider CALTRANS' proposed mitigation measures, as well as other potential measures, and assess how such measures could benefit the affected species or stocks and their habitat. Our evaluation of potential measures includes consideration of the following factors in relation to one another: (1) the manner in which, and the degree to which, we expect the successful implementation of the measure to minimize adverse impacts to marine mammals; (2) the proven or likely efficacy of the specific measure to minimize adverse impacts as planned; and (3) the practicability of the measure for applicant implementation.

Any additional mitigation measure proposed by us beyond what the applicant proposes should be able to or have a reasonable likelihood of accomplishing or contributing to the accomplishment of one or more of the following goals:

- Avoidance or minimization of marine mammal injury, serious injury, or death, wherever possible;
- A reduction in the numbers of marine mammals taken (total number or number at biologically important time or location);
- A reduction in the number of times the activity takes individual marine mammals (total number or number at biologically important time or location);
- A reduction in the intensity of the anticipated takes (either total number or number at biologically important time or location);
- Avoidance or minimization of adverse effects to marine mammal habitat, paying special attention to the food base; activities that block or limit passage to or from biologically important areas; permanent destruction of habitat; or temporary destruction/disturbance of habitat during a biologically important time; and
- For monitoring directly related to mitigation, an increase in the probability of detecting marine mammals, thus allowing for more effective implementation of the mitigation.

Alternative 1 (the Preferred Alternative) includes a suite of mitigation and monitoring measures intended to minimize potentially adverse interactions with marine mammals.

2.2 DESCRIPTION OF CALTRANS' PROPOSED ACTIVITY

The details of CALTRANS' SFOBB East Span Seismic Safety Project are provided described in the FHWA's 2001 FEIS and NMFS 2003 EA. Most of the construction activities have been completed and were not changed over the years, therefore, these details are incorporated by reference. The construction activities include in-water pile driving and pile removal using impact and vibratory hammers. However, as part of the dismantling phase of the SFOBB Project, CALTRANS is now proposing a demonstration project to remove Pier E3 of the original SFOBB by implosion using highly controlled charges. The means of using controlled implosion is proposed as an alternate method to the original permitted mechanical methods for dismantling Pier E3, as it is expected to result in fewer in-water work days, have fewer effects on aquatic resources of the Bay, and require a shorter time frame for completion.

In addition, to ensure that the Blast Attenuation System (BAS) for mitigation and the passive acoustic monitoring (PAM) for monitoring work properly during the implosion, CALTRANS is proposing a pre-implosion test charge using a small detonation three or four days before the actual SFOBB implosion. Detailed descriptions of CALTRANS' implosion activities are provided below.

Drilling Boreholes

Once the pier has been dismantled to the mechanical dismantling elevation, access platforms will be installed to support the drilling equipment while exposing the top of the interior cells and outside walls (marine mammal takes incidental to mechanical dismantling related activities are covered under an IHA issued to CALTRANS on July 15, 2015 [80 FR 43710]). Boreholes will be drilled on the inner cell walls and exterior walls of the pier for charge placement. An overhanging template system will be installed to guide the drill below the waterline. Divers will be required to cut notches to guide the drilling of underwater boreholes.

Blast Attenuation System Installation and Deployment

To minimize the potential impacts from shockwave generated from the bridge implosion, a Blast Attenuation System (BAS). The BAS to be used at Pier E3 is a modular system of pipe manifold frames that will be fed by 1,400 – 1,600 cubic feet per minute (cfm) air compressors to create a curtain of air bubbles around the entire pier during the controlled implosion. Proposed BAS design details and specifications are provided in Appendix B of CALTRANS' IHA application. Each BAS frame will be lowered to the bottom of the Bay by a barge mounted crane and positioned into place. Divers will be used to assist frame placement and to connect air hoses to the frames.

Based on location around the pier, the BAS frame elements will be situated from approximately 25 ft (7.6 m) to 40 ft (12 m) from the outside edge of Pier E3. The frames will be situated to contiguously surround the pier; frame ends will overlap to ensure no break in the BAS when operational. Each frame will be weighted to negative buoyancy for activation. Each BAS frame will be fed by an individual compressor mounted on a barge. This will require 14 compressors on approximately 14 flexi-float barges situated around the pier. Each barge will be temporarily anchored to maintain their position around the pier. Compressors will be turned on and each section of the BAS will be tested for uniform air flow prior to the controlled implosion. Once the controlled implosion event has been completed, the contractor will demobilize the BAS and all associated equipment. Compressors will provide enough pressure to achieve a minimal air volume fraction of 3 - 4%, consistent with the successful use of BAS systems in past controlled blasting activities (Kiewit-Mass, pers. comm. in: CALTRANS 2015).

System performance is anticipated to provide approximately 80% attenuation, or better, based on past experience with similar systems during controlled blasting. Previous implosions using similar BAS systems in Ontario, Canada showed 85%-95% attenuation, in Vancouver, Canada showed 84% - 88% attenuation, and in Manitoba, Canada showed 90 - 98% attenuation (Kiewit-Mason, pers. comm. in: CALTRANS 2015).

Pre-implosion Test Charge

Acoustically capturing the implosion is critical for the determination of whether or not this technique can be used for future piers. A key factor in accurately capturing hydroacoustic information is to ensure triggering of the data acquisition/recording instrument used for high speed recording during near-field and far-field monitoring of the implosion. To this end, the pressure-time signature of a blast cannot be duplicated except with another blast. As such, release of a small test charge before the actual implosion is required to validate that all equipment is functional and to set the triggering parameters accurately for the implosion.

Release of the test charge will occur at least three to four days prior to the actual implosion and after the BAS is in place and functional. The BAS will be in operation during the test. The test will use a charge weight of 18 grain (0.0025 lbs) or less. The charge will be placed along one of the longer faces of the Pier and inside the BAS while it is operating. The charge will be positioned near the center of the wider face of the pier to shield the areas on the opposite side as much as possible from sound. The charge will be placed approximately halfway between the face of the pier and the BAS. Note, the BAS may be located anywhere from 25 to 45ft from the face of the Pier. Monitoring inside the BAS will be done at a distance of 20 to 30 feet from the blast. Outside the BAS, monitoring will occur at a distance of 100 feet from the charge.

Controlled Implosion Dismantling of Remaining Pier

The controlled implosion event is scheduled to take place in November of 2015. Prior to the event, the bore holes in Pier E3 will be loaded with charges, as described in the Blast Plan (Appendix A of CALTRANS IHA application).

Individual cartridge charges, versus pump-able liquid blasting agents, have been chosen to provide greater accuracy in estimating the individual and total charge weights. Charges will be transported by boat to Pier E3. Security will be required for transporting, handling and processing of the charges.

Boreholes vary in diameter and depth and have been optimized for charge efficiency. Individual and total charge weight loads are provided in the Blast Plan. Charges are arranged in different levels (decks) separated in the boreholes by stemming. Stemming is the insertion of inert materials, like sand or gravel, to insulate and retain charges in an enclosed space. Stemming allows for more efficient transfer of energy into the structural concrete for fracture, and further reduces the release of potential energy into the adjacent water column.

The blast event will consist of a total of 588 individual delays of varying charge weight; the largest is 35 pounds/delay and the smallest is 21 pounds/delay. The blasting sequence is rather complex. On the full height walls, 30 pound weights will be used for the portion below mud line, 35 pound weights will be used in the lower structure immediately above mud line, 29.6

pounds in the midstructure, and 21 pounds in the upper structure. Blasts will start in several interior webs of the southern portion of the structure followed by the outer walls of the south side. The blasts in the inner walls will occur just prior to the adjacent outer walls. The interior first, exterior second blast sequence will continue across the structure moving from south to north. The time for the 588 detonations is 5.3 seconds with a minimum delay time of 9 milliseconds (ms) between detonations. As the blasting progresses, locations to east, north, and west of the pier will be shielded from the blasting on the interior of the structure from the still-standing exterior walls of the pier. However, towards the conclusion of the blast, each direction will experience blasts from the outer walls that are not shielded.

2.3 Description of Alternatives

2.3.1 Alternative 1 – Issuance of an Authorization with Mitigation Measures

The proposed action constitutes Alternative 1 and is the Preferred Alternative. Under this alternative, we would issue an IHA (valid from October 1 through December 30, 2015) to CALTRANS allowing the incidental take, by Level B harassment, of four species of marine mammals, subject to the mandatory mitigation and monitoring measures and reporting requirements set forth in the proposed IHA, if issued, along with any additions based on consideration of public comments.

MITIGATION AND MONITORING MEASURES

For CALTRANS' proposed Pier E3 demolition by implosion project, CALTRANS worked with NMFS and proposed the following mitigation and monitoring measures to minimize the potential impacts to marine mammals in the project vicinity. The primary purposes of these measures are to minimize sound levels from the implosion, to monitor marine mammals within designated zones and to ensure that no marine mammal is within a specific exclusion zone during the implosion.

Time Restriction

Implosion of Pier E3 would only be conducted during daylight hours and with enough time for pre and post implosion monitoring, and with good visibility when the largest exclusion zone can be visually monitored.

Installation of Blast Attenuation System (BAS)

Prior to the Pier E3 demolition, CALTRANS should install a Blast Attenuation System (BAS) as described above to reduce the shockwave from the implosion.

Establishment of Level A Exclusion Zone

Due to the different hearing sensitivities among different taxa of marine mammals, NMFS has established a series of take thresholds from underwater explosions for marine mammals belonging to different functional hearing groups (Table 1). Under these criteria, marine mammals from different taxa will have different impact zones (exclusion zones and zones of influence).

CALTRANS will establish an exclusion zone for both the mortality and Level A harassment zone (permanent hearing threshold shift or PTS, GI track injury, and slight lung injury) using the largest radius estimated harbor and northern elephant seals. Estimates are that the isopleth for PTS would extend out to a radius of 1,160 ft (354 m) for harbor and northern elephant seals and to 5,800 ft (1,768 m) for harbor porpoise; covering the entire areas for both Level A harassment and mortality. As harbor porpoises are unlikely to be in the area in

November, the exclusion zone boundaries would be set around the calculated distance to Level A harassment for harbor and northern elephant seals. However, real-time acoustic monitoring (i.e., active listening for vocalizations with hydrophones) also will be utilized to provide an additional level of confidence that harbor porpoises are not in the affected area.

Table 1. NMFS acoustic criteria for marine mammals in the SFOBB Pier E3 demolition area from underwater implosions

<table>
<tr><th rowspan="2">Group</th><th rowspan="2">Species</th><th colspan="2">Level B harassment</th><th>Level A harassment</th><th colspan="2">Serious injury</th><th rowspan="2">Mortality</th></tr>
<tr><th>Behavioral</th><th>TTS</th><th>PTS</th><th>Gastro-intestinal tract</th><th>Lung</th></tr>
<tr><td>High-freq cetacean</td><td>Harbor porpoise</td><td>141 dB SEL</td><td>146 dB SEL or 195 dB SPL_{pk}</td><td>161 dB SEL or 201 dB SPL_{pk}</td><td rowspan="3">237 dB SPL or 104 psi</td><td rowspan="3">$39.1M^{1/3} (1+[D/10.081])^{1/2}$ Pa-sec
where: M = mass of the animals in kg
D = depth of animal in m</td><td rowspan="3">$91.4M^{1/3} (1+[D/10.081])^{1/2}$ Pa-sec
where: M = mass of the animals in kg
D = depth of animal in m</td></tr>
<tr><td>Phocidae</td><td>Harbor seal & northern elephant seal</td><td>172 dB SEL</td><td>177 dB SEL or 212 dB SPL_{pk}</td><td>192 dB SEL or 218 dB SPL_{pk}</td></tr>
<tr><td>Otariidae</td><td>California sea lion</td><td>195 dB SEL</td><td>200 dB SEL or 212 dB_{pk}</td><td>215 dB SEL or 218 dB SPL_{pk}</td></tr>
</table>

* Note: All dB values are referenced to 1 μPa. SPL_{pk} = Peak sound pressure level; psi = pounds per square inch.

Adherence to calculated distances to Level A harassment for pinnipeds indicates that the radius of the exclusion zone would be 1,160 ft (354 m). The exclusion zone will be monitored by protected species observers (PSOs) and if any marine mammals are observed inside the exclusion, the implosion will be delayed until the animal leaves the area or at least 30 minutes have passed since the last observation of the marine mammal.

<u>Establishment of Level B Temporary Hearing Threshold Shift (TTS) Zone:</u>
As shown in Table 1, for harbor and northern elephant seals, this will cover the area out to 212 dB peak SPL or 177 dB SEL, whichever extends out the furthest. Hydroacoustic modeling indicates this isopleth would extend out to 5,700 ft (1,737 m) from Pier E3. For harbor porpoises, this will cover the area out to 195 dB peak SPL or 146 dB SEL, whichever extends out the furthest. Hydroacoustic modeling indicates this isopleth would extend out to 26,500 ft (8,077 m) from Pier E3. As discussed previously, the presence of harbor porpoises in this area is unlikely but monitoring (including real-time acoustic monitoring) will be employed to confirm their absence. For California sea lions, the distance to the TTS zone of influence will cover the area out to 212 dB peak SPL or 200 dB SEL. This distance was calculated at 470 ft (143 m) from Pier E3, well within the exclusion zone previously described.

<u>Establishment of Level B Behavioral Zone of Influence:</u>
As shown in Table 1, for harbor seals and northern elephant seals, this will cover the area out to 172 dB SEL. Hydroacoustic modeling indicates this isopleth would extend out to 9,700 ft (2,957 m) from Pier E3. For harbor porpoises, this will cover the area out to 141 dB SEL. Hydroacoustic modeling indicates this isopleth would extend out to 44,500 ft (13,564 m) from Pier E3. As discussed previously, the presence of harbor porpoises in this area is unlikely but monitoring (including real-time acoustic monitoring) will be employed to confirm their absence. For California sea lions, the distance to the Level B behavioral harassment ZOI will cover the area out to 195 dB SEL. This distance was calculated at 800 ft (244 m) from Pier E3, well within the exclusion zone previously described.

<u>Communication:</u>

All Protected Species Observers (PSOs) will be equipped with mobile phones and a VHF radio as a backup. One person will be designated as the Lead PSO and will be in constant contact with the Resident Engineer on site and the blasting crew. The Lead PSO will coordinate marine mammal sightings with the other PSOs and the real time acoustic monitor. PSOs will contact the other PSOs when a sighting is made within the exclusion zone or near the exclusion zone so that the PSOs within overlapping areas of responsibility can continue to track the animal and the Lead PSO is aware of the animal. If it is within 30 minutes of blasting and an animal has entered the exclusion zone or is near it, the Lead PSO will notify the Resident Engineer and blasting crew. The Lead PSO will keep them informed of the disposition of the animal.

Monitoring for implosion impacts to marine mammals will be based on the SFOBB pile driving monitoring protocol. Pile driving has been conducted for the SFOBB construction project since 2000 with development of several NMFS-approved marine mammal monitoring plans (CALTRANS 2004; 2013). Most elements of these marine mammal monitoring plans are similar to what would be required for underwater implosions. This monitoring plan includes monitoring an exclusion zone and ZOIs for TTS and behavioral harassment described above. In addition, CALTRANS shall implement passive acoustic monitoring. All monitoring would be conducted by NMFS-approved PSOs.

Protected Species Observers:
A minimum of 8-10 PSOs would be required during the Pier E3 controlled implosion so that the exclusion zone, Level B Harassment TTS and Behavioral ZOIs, and surrounding area can be monitored. The size of this area may be revised as further information is obtained regarding the amount of charges and from corresponding changes in the size of the Level A and Level B Harassment zones from hydroacoustic modeling. One PSO would be designated as the Lead PSO and would be located with the Department Engineer and the Blasting Supervisor (or person that will be in charge of detonating the charges) during the implosion. The Lead PSO would receive updates from other PSOs on the presence or absence of marine mammals within the exclusion zone and would notify the Blasting Supervisor of a cleared exclusion zone to the implosion.

Monitoring Protocol:
The Lead PSO will be in contact with other PSOs and the acoustic monitors. As the time for the implosion approaches, any marine mammal sightings would be discussed between the Lead PSO, the Resident Engineer, and the Blasting Supervisor. If any marine mammals enter the exclusion zone within 30 minutes of blasting, the Lead PSO will notify the Resident Engineer and Blasting Supervisor that the implosion may need to be delayed. The Lead PSO will keep them informed of the disposition of the animal. If the animal remains in the exclusion zone, blasting will be delayed until it has left the exclusion zone. If the animal dives and is not seen again, blasting will be delayed at least 30 minutes. Once the implosion has occurred, the PSOs will continue to monitor the area for at least 60 minutes.

Post-implosion Survey:
Although any injury or mortality from the implosion of Pier E3 is very unlikely, boat or shore surveys will be conducted for the three days following the event to determine if there are any injured or stranded marine mammals in the area. If an injured or dead animal is discovered during these surveys or by other means, the NMFS-designated stranding team will be contacted to pick up the animal. Veterinarians will treat the animal or conduct a necropsy to attempt to determine if it stranded was a result of the Pier E3 implosion.

Monitoring Data Collection:
Each MMO will record their observation position, start and end times of observations, and weather conditions (sunny/cloudy, wind speed, fog, visibility). For each marine mammal sighting, the following will be recorded, if possible:

- Species
- Number of animals (with or without pup/calf)
- Age class (pup/calf, juvenile, adult)
- Identifying marks or color (scars, red pelage, damaged dorsal fin, etc.)
- Position relative to Pier E3 (distance and direction)
- Movement (direction and relative speed)
- Behavior (logging [resting at the surface], swimming, spyhopping [raising above the water
- surface to view the area], foraging, etc.)
- Duration of sighting or times of multiple sightings of the same individual

Real Time Acoustic Monitoring for Harbor Porpoises:
While harbor porpoises are not expected to be within the CALTRANS' Pier E3 implosion Level B TTS ZOI (within 26,500 ft [8,077 ms]) in November, real time acoustic monitoring to confirm species absence is proposed as an avoidance measure in addition to active monitoring by trained visual PSOs. Harbor porpoises vocalize frequently with other animals within their group, and use echolocation to navigate and to locate prey. Therefore, as an additional monitoring tool, a real time acoustic monitoring system will be used to detect the presence or absence of harbor porpoises as a supplement to visual monitoring.

The system would involve two bio-acousticians monitoring the site in real time, likely near the north end of Treasure Island as most harbor porpoises appear to pass through the area north of Treasure Island before heading south toward the East Span of the SFOBB. A calibrated hydrophone or towed array would be suspended from a boat and/or several sonobuoys (acoustic information is sent via telemetry to the acoustic boat) or a hydrophone moored offshore with a cable leading to a shore based acoustic station will be deployed outside of the monitoring area of Pier E3. All equipment will be calibrated and tested prior to the implosion to ensure functionality. This system would not be able to give an accurate distance to the animal but would either determine that no cetaceans are in the area or would provide a relative distance and direction so that PSOs could search for the cetaceans and determine if those animals have entered or may enter the Pier E3 implosion area. The bio-acousticians would be in communication with the Lead PSO and would alert the crew to the presence of any cetacean approaching the monitoring area. It would also provide further confirmation that there are no cetaceans around Pier E3 in addition to the visual observations documenting no observations.

Hydroacoustic Monitoring for Underwater Implosion
The purpose of hydroacoustic monitoring during the controlled implosion of Pier E3 is twofold: 1) to evaluate distances to marine mammal impact noise criteria; and 2) to improve the prediction of underwater noise for assessing the impact of the demolition of the remaining piers through future controlled implosions.

Monitoring of the implosion is specific to two regions around Pier E3 with unique methods, approaches, and plans for each of these regions. These regions include the “near field” and the “far field”. For Pier E3, the near field will comprise measurements taken within 500 ft of the pier while the far field will comprise measurements taken at 500 feet and all greater distances.

Measurements inside the BAS will be made with near and far field systems using PCB 138A01 transducers. At the 100-ft distance, the near field system will use another PCB 138A01 transducer while the far field system will use both a PCB 138A01 transducer and a Reson TC4013 hydrophone. Prior to activating the BAS, ambient noise levels will be measured. While the BAS is operating and before the test, background noise measurements will also be made. After the test, the results will be evaluated to determine if any final adjustments are needed in the measurement systems prior to the implosion. Pressure signals will be analyzed for peak pressure and SEL values prior to the scheduled time of the implosion.

Marine Mammal Stranding Plan

In addition, a stranding plan will be prepared in cooperation with the local NMFS-designated marine mammal stranding, rescue, and rehabilitation center. Although mitigation measures would likely prevent any injuries, preparations will be made in the unlikely event that marine mammals are injured. Elements of that plan would include the following:

1. The stranding crew would prepare treatment areas at the NMFS-designated facility for cetaceans or pinnipeds that may be injured from the implosion. Preparation would include equipment to treat lung injuries, auditory testing equipment, dry and wet caged areas to hold animals, and operating rooms if surgical procedures are necessary. Equipment to conduct auditory brainstem response hearing testing would be available to determine if any inner ear threshold shifts (TTS or PTS) have occurred (Thorson et al. 1999).

2. A stranding crew and a veterinarian would be on call near the Pier E3 site at the time of the implosion to quickly recover any injured marine mammals, provide emergency veterinary care, stabilize the animal’s condition, and transport individuals to the NMFS-designated facility. If an injured or dead animal is found, NMFS (both the regional office and headquarters) will be notified immediately even if the animal appears to be sick or injured from other than blasting.

3. Post-implosion surveys would be conducted immediately after the event and over the following three days to determine if there are any injured or dead marine mammals in the area.

4. Any veterinarian procedures, euthanasia, rehabilitation decisions and time of release or disposition of the animal will be at the discretion of the NMFS-designated facility staff and the veterinarians treating the animals. Any necropsies to determine if the injuries or death of an animal was the result of the blast or other anthropogenic or natural causes will be conducted at the NMFS-designated facility by the stranding crew and veterinarians. The results will be communicated to both the Department and to NMFS as soon as possible with a written report within a month.

2.3.2 ALTERNATIVE 2 – NO ACTION ALTERNATIVE

Under the No Action Alternative, NMFS would not issue the requested IHA to CALTRANS for the potential take of marine mammals, by harassment, incidental to conducting Pier E3 demolition using controlled implosion. The MMPA prohibits all takings of marine mammals unless authorized by a permit or exemption under the MMPA. The consequences of not authorizing incidental takes are (1) the entity conducting the activity may be in violation of the MMPA if takes do occur, (2) mitigation and monitoring measures cannot be required by NMFS, and (3) mitigation measures might not be performed voluntarily by the applicant. By undertaking measures to further protect marine mammals from incidental take through the authorization program, the impacts of these activities on the marine environment can potentially be lessened. While NMFS does not authorize the controlled implosion for bridge demolition, NMFS does authorize the unintentional, incidental take of marine mammals (under its jurisdiction) in connection with the activity and prescribes, where applicable, the methods of taking and other means of effecting the least practicable impact on the species and stocks and their habitats. If an IHA is not issued, CALTRANS would be effectively precluded from using the controlled implosion to demolish the Pier E3 structure, as any take of marine mammals under such a method would not be covered under the MMPA. As a result, CALTRANS would have to use mechanical methods to demolish the Pier E3 structure, which would require months of additional in-water work time, and would have more impacts on aquatic resources of the San Francisco Bay, including marine mammals through longer term noise exposure. In this case, CALTRANS would have to apply for an IHA to conduct East Span Pier 3 dismantling using mechanical means.

2.3.3 ALTERNATIVES CONSIDERED BUT ELIMINATED FROM DETAILED STUDY

NMFS considered an alternative where NMFS would issue an IHA without the mitigation measures described in Alternative 1–Issuance of an IHA with Mitigation (the Preferred Alternative). This alternative, however, failed to meet the statutory and regulatory requirements of the MMPA (e.g., negligible impact, effecting the least practicable adverse impact, and monitoring and reporting of such takings) because the MMPA requires certain monitoring and mitigation measures to be implemented to reduce the effects on marine mammals. Accordingly, NMFS did not consider this alternative further.

Chapter 3 Affected Environment

A description of the San Francisco Bay ecosystem, its associated marine mammals and other marine and estuarine life can be found in the FHWA FEIS (FHWA, 2001), especially in Chapter 3.9 of that document, which is incorporated in this part by reference.

Detailed descriptions on the biology, distribution, and status of California sea lions (*Zalophus californianus*) and Pacific harbor seals (*Phoca vitulina richardsii*) are provided in NMFS 2003 EA, and a description of harbor porpoise (*Phocoena phocoena*) is provided in NMFS 2009 SEA, which are incorporated in this part by reference. However, NMFS 2003 EA and 2009 SEA did not address northern elephant seal (*Mirounga angustirostris*). CALTRANS states that northern elephant seals could occur in the vicinity of the Pier E3 proposed action area. Therefore, this SEA provides a brief discussion of northern elephant seals and the potential impacts from the proposed controlled implosion activity.

3.1 Northern Elephant Seal

Status:
The northern elephant seal is protected under the MMPA, but is not listed as a strategic or depleted species under the MMPA (Carretta *et al*. 2014), or listed as endangered or threatened under the ESA. The population size for the California breeding stock is estimated at 124,000 to 179,000 seals and is increasing (Lowry *et al*. 2010; Carretta *et al*. 2012).

Distribution:
Northern elephant seals are common on California coastal mainland and island sites where they pup, breed, rest and molt. The largest rookeries are on San Nicolas and San Miguel islands in the Northern Channel Islands. Near the Bay, elephant seals breed, molt, and haul out at Año Nuevo Island, the Farallon Islands, and Point Reyes National Seashore.

Northern elephant seals haul out to give birth and breed from December through March. Pups remain onshore or in adjacent shallow water through May. Both sexes make two foraging migrations each year: one after breeding and the second after molting (Stewart 1989; Stewart and DeLong 1995). Pup mortality is high when they make the first trip to sea in May and this period correlates with the time of most strandings. Pups of the year return in the late summer and fall to haul out at rookery sites but may occasionally make brief stops in the Bay.

SFOBB Area:
The number of juvenile elephant seals near the Pier E3 area is relatively low compared to the rest of the Bay (~100 vs. < 10 per year) or to the number of sea lions or harbor seals observed. Healthy elephant seals are rarely observed near the Pier E3 area (only one in 2012 on the beach at Clipper Cove on Treasure Island) (CALTRANS 2015).

The Marine Mammal Center provided information that approximately 100 juvenile elephant seals strand each year in the entire San Francisco Bay with only 10 or fewer juvenile elephant seals stranding on Treasure Island and Yerba Buena Island each year. This was the only available information on the presence of elephant seals (except the one sighting) near the Pier E3 area (Phil Thorson, pers. comm. June 30, 2015).

CHAPTER 4 ENVIRONMENTAL CONSEQUENCES

This chapter of the EA analyzes the impacts of the two alternatives and addresses the potential direct, indirect, and cumulative impacts of our issuance of an IHA. CALTRANS's application and other related environmental analyses identified previously facilitate this analysis.

Under the MMPA, we have evaluated the potential impacts of CALTRANS's Pier E3 controlled implosion activity in order to determine whether to authorize incidental take of marine mammals. Under NEPA, we have determined that a SEA is appropriate to evaluate the potential significance of environmental impacts resulting from the issuance of an IHA.

4.1 EFFECTS OF ALTERNATIVE 1: ISSUANCE OF AN IHA WITH MITIGATION MEASURES (PREFERRED ALTERNATIVE)

Alternative 1 is the Preferred Alternative, under which we would issue an IHA to CALTRANS allowing the incidental take, by Level B harassment, of 4 species of marine mammals from October 1 through December 30, 2015, subject to the mandatory mitigation and monitoring measures and reporting requirements set forth in the IHA, if issued. We would incorporate the mitigation and monitoring measures and reporting described earlier in this SEA into a final IHA.

4.1.1 IMPACTS TO MARINE MAMMALS

We expect that an intense impulse from the proposed Pier E3 controlled implosion would have the potential to impact marine mammals in the vicinity. The majority of impacts would be startle behavioral and temporary behavioral modification from marine mammals. However, a few individuals of animals could be exposed to sound levels that would cause temporal hearing threshold shift (TTS).

Impacts from Underwater Detonations in Free Field Environment at Close Range

The underwater explosion would send a shock wave and blast noise through the water, release gaseous by-products, create an oscillating bubble, and cause a plume of water to shoot up from the water surface. The shock wave and blast noise are of most concern to marine animals. The effects of an underwater explosion on a marine mammal depends on many factors, including the size, type, and depth of both the animal and the explosive charge; the depth of the water column; and the standoff distance between the charge and the animal, as well as the sound propagation properties of the environment. Potential impacts can range from brief effects (such as behavioral disturbance), tactile perception, physical discomfort, slight injury of the internal organs and the auditory system, to death of the animal (Yelverton *et al.* 1973; DoN, 2001). Non-lethal injury includes slight injury to internal organs and the auditory system; however, delayed lethality can be a result of individual or cumulative sublethal injuries (DoN, 2001). Immediate lethal injury would be a result of massive combined trauma to internal organs as a direct result of proximity to the point of detonation (DoN, 2001). Generally, the higher the level of impulse and pressure level exposure, the more severe the impact to an individual.

Injuries resulting from a shock wave take place at boundaries between tissues of different density. Different velocities are imparted to tissues of different densities, and this can lead to their physical disruption. Blast effects are greatest at the gas-liquid interface (Landsberg 2000). Gas-containing organs, particularly the lungs and gastrointestinal tract, are especially susceptible (Goertner 1982; Hill 1978; Yelverton *et al.* 1973). In addition, gas-containing organs including the nasal sacs, larynx, pharynx, trachea, and lungs may be damaged by compression/expansion caused by the oscillations of the blast gas bubble. Intestinal walls can bruise or rupture, with subsequent hemorrhage and escape of gut contents into the body cavity. Less severe gastrointestinal tract injuries include contusions, petechiae (small red or purple spots caused by bleeding in the skin), and slight hemorrhaging (Yelverton *et al.* 1973).

Because the ears are the most sensitive to pressure, they are the organs most sensitive to injury (Ketten 2000). Sound-related damage associated with blast noise can be theoretically distinct from injury from the shock wave, particularly farther from the explosion. If an animal is able to hear a noise, at some level it can damage its hearing by causing decreased sensitivity (Ketten 1995). Sound-related trauma can be lethal or sublethal. Lethal impacts are those that result in immediate death or serious debilitation in or near an intense source and are not, technically, pure acoustic trauma (Ketten 1995). Sublethal impacts include hearing loss, which is caused by exposures to perceptible sounds. Severe damage (from the shock wave) to the ears includes tympanic membrane rupture, fracture of the ossicles, damage to the cochlea, hemorrhage, and cerebrospinal fluid leakage into the middle ear. Moderate injury implies partial hearing loss due to tympanic membrane rupture and blood in the middle ear. Permanent hearing loss also can occur when the hair cells are damaged by one very loud event, as well as by prolonged exposure to a loud noise or chronic exposure to noise. The level of impact from blasts depends on both an animal's location and, at outer zones, on its sensitivity to the residual noise (Ketten, 1995).

Confined Detonation and Associated Level B Harassment

However, the above discussion concerning underwater explosion only pertains to open water detonation in a free field. CALTRANS' Pier E3 demolition project using controlled implosion uses a confined detonation method, meaning that the charges will be placed within the structure. Therefore, most energy from the explosive shock wave would be absorbed through the destruction of the structure itself, and would not propagate through the open water. Measurements and modeling from confined underwater detonation for structure removal showed that energy from shock waves and noise impulses were greatly reduced in the water column (Hempen *et al.* 2007). Therefore, with monitoring and mitigation measures discussed above, CALTRANS Pier E3 controlled implosion is not likely to have the injury or mortality effects on marine mammals in the project vicinity. Instead, NMFS considers that CALTRANS' proposed Pier E3 controlled implosion in the San Francisco Bay is most like to cause Level B behavioral harassment and maybe TTS in a few individual of marine mammals, as discussed below.

Changes in marine mammal behavior are expected to result from an acute stress response. This expectation is based on the idea that some sort of physiological trigger must exist to change any behavior that is already being performed. The exception to this rule is the case of auditory masking, which is not likely since the CALTRANS' controlled implosion is only one short of sequential detonations that last for approximately 5 seconds.

Numerous behavioral changes can occur as a result of stress response. For each potential behavioral change, the magnitude in the change and the severity of the response needs to be estimated. Certain conditions, such as stampeding (i.e., flight response) or a response to a predator, might have a probability of resulting in injury. For example, a flight response, if significant enough, could produce a stranding event. Each disruption to a natural behavioral pattern (e.g., breeding or nursing) may need to be classified as Level B harassment. All behavioral disruptions have the potential to contribute to the allostatic load. This secondary potential is signified by the feedback from the collective behaviors to allostatic loading.

Marine mammals exposed to high intensity sound repeatedly or for prolonged periods can experience hearing threshold shift (TS), which is the loss of hearing sensitivity at certain frequency ranges (Kastak *et al.* 1999; Schlundt *et al.* 2000; Finneran *et al.* 2002; 2005). TS can be permanent (PTS), in which case the loss of hearing sensitivity is unrecoverable, or temporary (TTS), in which case the animal's hearing threshold will recover over time (Southall *et al.* 2007). Since marine mammals depend on acoustic cues for vital biological functions, such as orientation, communication, finding prey, and avoiding predators, marine mammals that suffer from PTS or TTS will have reduced fitness in survival and reproduction, either permanently or temporarily. Repeated noise exposure that leads to TTS could cause PTS.

Experiments on a bottlenose dolphin and beluga whale (*Delphinapterus leucas*) showed that exposure to a single watergun impulse at a received level of 207 kPa (or 30 psi) peak-to-peak (p-p), which is equivalent to 228 dB re 1 μPa (p-p), resulted in a 7 and 6 dB TTS in the beluga whale at 0.4 and 30 kHz, respectively. Thresholds returned to within 2 dB of the pre-exposure level within 4 minutes of the exposure (Finneran *et al.* 2002). No TTS was observed in the bottlenose dolphin. Although the source level of pile driving from one hammer strike is expected to be much lower than the single watergun impulse cited here, animals being exposed for a prolonged period to repeated hammer strikes could receive more noise exposure in terms of SEL than from the single watergun impulse in the aforementioned experiment (Finneran *et al.* 2002).

4.1.2 IMPACTS TO MARINE MAMMAL HABITAT

The proposed Pier E3 demolition using controlled implosion will not result in any permanent impact on habitats used by marine mammals, and potentially short-term to minimum impact to the food sources such as forage fish. There are no known haul-out sites, foraging hotspots, or other ocean bottom structures of significant biological importance to harbor seals, northern elephant seals, California sea lions, or harbor porpoises within San Francisco Bay. Therefore, the main impact associated with the activity will be the removal of an existing bridge structure.

Fish that are located in the water column, in close proximity to the source of the controlled implosion could be injured, killed, or disturbed by the impulsive sound and could leave the area temporarily. Continental Shelf Associates, Inc. (2002) summarized a few studies conducted to determine effects associated with removal of offshore structures (e.g., oil rigs) in the Gulf of Mexico. Their findings revealed that at very close range, underwater explosions are lethal to most fish species regardless of size, shape, or internal anatomy. In most situations, cause of death in fish has been massive organ and tissue damage and internal bleeding. At longer range, species with gas-filled swimbladders (e.g., snapper, cod, and striped bass) are more susceptible than those without swimbladders (e.g., flounders, eels).

Studies also suggest that larger fish are generally less susceptible to death or injury than small fish. Moreover, elongated forms that are round in cross section are less at risk than deep-bodied forms. Orientation of fish relative to the shock wave may also affect the extent of injury. Open water pelagic fish (e.g., mackerel) seem to be less affected than reef fishes. The results of most studies are dependent upon specific biological, environmental, explosive, and data recording factors.

The huge variation in fish populations, including numbers, species, sizes, and orientation and range from the detonation point, makes it very difficult to accurately predict mortalities at any specific site of detonation. Most fish species experience a large number of natural mortalities, especially during early life-stages, and any small level of mortality caused by the CALTRANS' one time controlled implosion will likely be insignificant to the population as a whole.

Therefore, potential impacts to marine mammal food resources within the San Francisco Bay are expected to be minimal given both the very geographic and spatially limited scope of the proposed implosion, and the high biological productivity of these resources. No short or long term effects to marine mammal food resources from CALTRANS' activity are anticipated within the San Francisco Bay.

4.1.3 ESTIMATED TAKE OF MARINE MAMMALS BY LEVEL B HARASSMENT

Numbers of marine mammals within the Bay may be incidentally taken during demolition using controlled charges (impulse sound) related to the demolition of the original East Span of the SFOBB were calculated based on acoustic propagation models for each functional hearing group and the estimated density of each species in the project vicinity. Specifically, the takes estimates are calculated by multiplying the ensonified areas that are specific to each functional hearing group by the density of the marine mammal species.

4.1.3.1 Marine Mammal Density Estimates

There are no systematic line transect surveys of marine mammals within San Francisco Bay, therefore, the in water densities of harbor seals, California sea lions, and harbor porpoises were calculated from 14 years of observations during monitoring for the SFOBB construction and demolition. During the 210 days of monitoring (including 15 days of baseline monitoring in 2003), 657 harbor seals, 69 California sea lions and three harbor porpoises were observed within the waters of the east span of the SFOBB. Density estimates for other species were made from stranding data provided by the MMC (Sausalito, CA; Northern elephant seal).

Pacific Harbor Seal

Most data on harbor seal populations are collected while the seals are hauled out. This is because it is much easier to count individuals when they are out of the water. In-water density estimates rely on haul-out counts, the percentage of seals not on shore based on radio telemetry studies, and the size of the foraging range of the population. Harbor seal density in the water can vary greatly depending on weather conditions or the availability of prey. For example, during Pacific herring runs further north in the Bay (near Richardson Bay, outside of the Pier E3 hydroacoustic zone) in February 2014, very few harbor seals were observed foraging near Yerba Buena Island (YBI) or transiting through the SFOBB area for approximately two weeks. Sightings went from a high of 16 harbor seal individuals foraging or in transit in one day to 0-2 seals per day in transit or foraging through the SFOBB area (Department 2014). Calculated harbor seal density is a per day estimate of harbor seals in a 1 km^2 area within the fall/winter or spring/summer seasons.

Harbor seal density for the proposed project was calculated from all observations during SFOBB Project monitoring from 2000 to 2014. These observations included data from baseline, pre, during and post pile driving and onshore implosion activities. During this time, the population of harbor seals within the Bay has remained stable (Manugian 2013), therefore, we do not anticipate significant differences in numbers or behaviors of seals hauling out, foraging or in their movements over that 15 year period. All harbor seal observations within a km2 area were used in the estimate. Distances were recorded using a laser range finder (Bushnell Yardage Pro Elite 1500; ± 1.0 yards accuracy). Care was taken to eliminate multiple observations of the same animal although this was difficult when more than three seals were foraging in the same area.

Density of harbor seals was highest near YBI and Treasure Island, probably due to the haul-out site and nearby foraging areas in the Coast Guard and Clipper coves. Therefore, density estimates were calculated for a higher density area within 3,936 ft (1,200 m) west of Pier E3, which includes these two foraging coves. A lower density estimate was calculated from the area east of Pier E3 and beyond 3,936 ft (1,200 m) to the north and south of Pier E3.

These density estimates were then extrapolated to the threshold criteria areas delineated by the hydroacoustic models to calculate the number of harbor seals likely to be exposed.

California Sea Lion

Most data on California sea lion populations are collected while the seals are hauled out as it is much easier to count individuals when they are out of the water. In-water density estimates rely on haul-out counts, the percentage of sea lions not on shore based on radio telemetry studies, and the size of the foraging range of the population. Sea lion density, like harbor seal densities, in the water can vary greatly depending on weather conditions, the availability of prey, and the season. For example, sea lion density increases during the summer and fall after the end of the breeding season at the Southern California rookeries.

For the proposed project, California sea lion density was calculated from all observations during SFOBB monitoring from 2000 to 2014. These observations included data from baseline, pre, during and post pile driving and onshore implosion activities. During this time, the population of sea lions within the Bay has remained stable as have the numbers observed near the SFOBB (Manugian 2013). As a result, we do not anticipate significant differences in the number of sea lion or their movements over that 15 year period. All sea lion observations within a km^2 area were used in the estimate. Distances were recorded using a laser range finder (Bushnell Yardage Pro Elite 1500; ± 1.0 yards accuracy). Care was taken to eliminate multiple observations of the same animal, although most sea lion observations involve a single animal. Calculated California sea lion density is a per day estimate of sea lions in a one km^2 area within the fall/winter or spring/summer seasons.

Northern Elephant Seal

Northern elephant seal density around Pier E3 was calculated from the stranding records of the MMC from 2004 to 2014. These data included both injured or sick seals and healthy seals. Approximately 100 elephant seals were reported within the Bay during this time, most of these hauled out and were likely sick or starving. The actual number of individuals within the Bay may be higher as not all individuals would necessarily have hauled out. Some individuals may have simply left the Bay soon after entering. Data from the MMC show several elephant seals stranding on Treasure Island and one healthy elephant seal was observed resting on the beach in Clipper Cove in 2012. Elephant seal pups or juveniles also may strand after weaning in the spring and when they return to California in the fall (September through November).

Harbor Porpoise

Harbor porpoise density was calculated from all observations during SFOBB monitoring from 2000 to 2014. These observations included data from baseline, pre, during and post pile driving and onshore implosion activities. Over this period, the number of harbor porpoises that were observed entering and using the Bay increased. During the fifteen years of observational data around the SFOBB Project, only four harbor porpoises were observed and all occurred from 2006 to 2014 (including two in 2014). All harbor porpoise observations within a km^2 area were used in the estimate. Distances were recorded using a laser range finder (Bushnell Yardage Pro Elite 1500; ± 1.0 yards accuracy).

A summary of marine mammal density information is provided in Table 2.

Table 2. Estimated in-water density of marine mammals that may occur in the vicinity of CALTRANS' proposed Pier E3 controlled implosion area.

Species	Main Season Of Occurrence	Density Within 1,200m of SFOBB (animals/km^2)	Density Beyond 1,200m of SFOBB (animals/km^2)
Pacific Harbor Seal	Spring – Summer (pupping/molt seasons)	0.30	0.15
Pacific Harbor Seal	Fall- Winter	0.77	0.15
Sea Lion	Late Summer – Fall (Post Breeding Season)	0.12	0.12
Sea Lion	Late Spring-Early Summer (Breeding Season)	0.06	0.06
Northern Elephant seal	Late Spring-Early Winter (Pups After First Trip To Sea)	0.03	0.03
Harbor Porpoise	All Year	Very Low estimated at 0.004	Very Low estimated at 0.004

4.1.3.2 Impact Zones Modeling

Since the proposed Pier E3 controlled implosion would be carried as a confined explosion, certain elements were taken into the modeling process beyond a simple open-water blast model. Confinement is a concept in blasting that predicts the amount of blast energy that is expected to be absorbed by the surrounding structural material, resulting in the fracturing necessary for demolition. The energy beyond that absorbed by the material is the energy that produces the pressure wave propagating away from the source. NMFS has determined that modeling with confinement was appropriate for the proposed Pier E3 blast by evaluating blast results from case study data for underwater implosions similar to the proposed SFOBB Pier E3 implosion. In addition, the NMFS worked with CALTRANS and compared case study results to published blast models that incorporate a degree of confinement.

Data from 39 comparable underwater concrete blasts were used by CALTRANS to evaluate potential equations for modeling blast-induced peak pressures and subsequent effects to marine mammals (Kiewit-Mason, pers. Comm 2015 in CALTRANS 2015). All 39 blasts occurred in approximately 55 ft (16.8 m) of water, similar to the maximum water depth around Pier E3. In addition, all blasts had burdens (i.e., distance from the charge to the outside side of the material being fractured) of approximately 1.5 to 2 ft (0.5 to 0.6 m). Burdens for Pier E3 also are estimated to be in this range. Data provided included the charge weight, observed peak pressure, distance of peak pressure observation, and the modeled peak pressure using Cole's confined equation, Cole's unconfined equation, and Oriard's conservative concrete equation (Cole 1948; Oriard 2002).

Using these data, appropriate equations for modeling the associated hydroacoustic impacts are established for the Pier E3 controlled implosion. Cole's unconfined equation greatly overestimated peak pressures for all blasts while Cole's confined equation appeared to most accurately predict observed peak pressures. Oriard's conservative concrete equation overestimated peak pressures, but not as dramatically as under Cole's unconfined equation. NMFS and CALTRANS have opted to use more conservative methods to ensure an additional level of safety when predicting the monitoring zone and potential impact areas to marine mammals from the proposed controlled implosion project.

The applicable metrics discussed are the peak pressure (P_{pk}) expressed in dB, the accumulated sound exposure level (SEL) also expressed in dB, and the positive acoustic impulse (I) in Pa-sec. The criteria for marine mammals are grouped into behavioral response, slight injury, mortality, and the specific acoustic thresholds depend on group and species. These are summarized in Table 1. The metrics for these are criteria defined as:

Peak pressure level

$$L_{pk} = 20\log_{10}\left(P_{pk}/P_{ref}\right) \qquad (1)$$

where L_{pk} is the peak level in dB and P_{ref} is the reference pressure of 1μPa;

SEL

$$SEL = 20\log_{10}\left(\int_0^T \frac{P^2(t)dt}{P_{ref}^2 \cdot T_{ref}}\right) \qquad (2)$$

where T is the duration of the event, $P^2(t)$ is the instantaneous pressure squared and T_{ref} is the reference time of 1 second;

Impulse:

$$I = \int_0^T \left(P(t)dt/P_{ref}\right) \qquad (3)$$

where T is the duration of the initial positive portion of $P(t)$. In order to calculate these quantities, $P(t)$ for the blast event is needed as a function of distance from the blast, or alternatively, empirical relationship can be used for L_{pk} and I.

General Assumptions

The blast event will consist of a total of 588 individual delays of varying charge weight; the largest is 35 pounds/delay and the smallest is 21 pounds/delay. The blasting sequence is rather complex. On the full height walls, 30 pound weights will be used for the portion below mud line, 35 pound weights will be used in the lower structure immediately above mud line, 29.6 pounds in the midstructure, and 21 pounds in the upper structure. Full details on the delay weights and locations can be found in the Blast Plan (CALTRANS 2015). Blasts will start in several interior webs of the southern portion of the structure followed by the outer walls of the south side. The blasts in the inner walls will occur just prior to the adjacent outer walls. The interior first, exterior second blast sequence will continue across the structure moving from south to north. The time for the 588 detonations is 5.3 seconds with a minimum delay time of 9 milliseconds (ms) between detonations. As the blasting progresses, locations to east, north, and west of the pier will be shielded from the blasting on the interior of the structure from the still-standing exterior walls of the pier. However, towards the conclusion of the blast, each direction will experience blasts from the outer walls that are not shielded.

To estimate P_{pk} and $P^2(t)$, several assumptions were made. For simplification, it was assumed that there is only one blast distance and it is to the closest point on the pier from the receiver point. In actuality for almost all explosions, distances from the blast will be greater as the pier is approximately 135 ft (41 m) across and 80 ft (24 m) wide. Based on these dimensions, the actual blast point could be up to 135 ft (41 m) further from the receptor point used for the calculation. As a result, the calculated peak level is the maximum expected for one 35 pound blast while the other levels would be lower depending on the distance from the actual blast location to the calculation point and weight of the charge. In other words, the pressure received at the calculation point would not be 588 signals of the same amplitude, but would be from one at the estimated level for a 35 pound charge and 587 of varying lower amplitudes. Similarly, in the vertical direction, the location varies over a height of about 50 ft (15 m) and those blasts that are not at the same depth as the receiver would also be lower. This effect of variation in assumed blast to receiver distance will be most pronounced close to the pier, while at distances of about 1,000 ft (305 m) or greater, the effect would be less than 1 dB.

In the calculations, it was also assumed that there would be no self-shielding of the pier as the explosions progress. From the above discussion of the blast sequence, some shielding of the blasts along the interior of the pier will occur. However, the blasts that occur in outer wall (towards the end of the implosion) will not be shielded for all blasts. A blast in the outer wall that has a direct line of sight to the receptor calculation point will not be shielded and will generate the highest peak pressure relative to be compared to the L_{pk} criterion. The cumulative SEL and the root-mean-squared (RMS) levels; however, will be reduced to some degree by the outer walls until they are demolished as these metrics are defined by the pressure received throughout the entire 5.3 second event. However, due to the complexity of the blast sequence, this shielding effect was not considered in the calculated SEL and RMS levels.

Based on the Blast Plan (CALTRANS 2015), the delays are to be placed in 2¾ to 3 inch (7 to 7.6 cm) diameter holes drilled into the concrete pier structure. The outer walls of the pier are nominally 3 ft-11½ inch (1.5 m) thick and inner walls are nominally 3 ft (0.9 m) thick. Individual blasts should be not exposed to open water and some confinement of the blasts is expected. For confined blasts, the predicted pressures can be reduced by 65 to 95% (Nedwell and Thandavamoorthy 1992; Rickman 2000; Oriard 2002; Rivey 2011), corresponding to multiplication factors from 0.35 to 0.05, respectively. Based on a review of the available literature and recent data from similar explosive projects, the Department has decided to use a conservative confinement factor of K=7500 which equates to a 65% reduction in pressure and by a multiplication factor of 0.3472 (Eq. 4).

Another assumption was to consider only the direct wave from an individual blast. In shallow water, the signal at the receiver point could consist of the direct wave, surface-relief wave generated by the water/air interface, a reflected wave from the bottom, and a wave transmitted through the bottom material (USACE 1991). For estimating P_{pk}, only the direct wave is considered as it will have the highest magnitude and will arrive at the receiver location before any other wave component. However, $P(t)$ after the arrival of the direct wave peak pressure will be effected. The surface-relief wave is negative so that when it arrives at the receiver location, it will reduce the positive pressure of the direct wave and can make the total pressure negative at times after the arrival of the initial positive peak pressure. Since the SEL is a pressure squared quantity, any negative pressure can also contribute to the SEL. However, the amplitude and arrival time of the surface-relief wave depends on the geometry of the propagation case, that is, depth of water, depth of blast, and distance and depth of the receiver point. The effect of this assumption is discussed further in the section on SEL.

Estimation of Peak Pressure

Peak pressures were estimated by following the modified version of the Cole Equation for prediction of blasts in open, deep water (Cole 1948). The peak pressure is determined by:

$$P_{pk} = K(\lambda)^{-1.13} \qquad (4)$$

where P_{pk} is peak pressure in pounds per square inch (psi), and λ is the scaled range given by $R/W^{1/3}$ in which R is the distance in feet and W is the weight of the explosive charge in pounds. A modified version of the Cole Equation has been documented in U.S. Army Corps of Engineer (USACE) Technical Letter No. 1110-8-11(FR) and is applicable to shallow water cases such as that of the Pier E3 demolition (USACE 1991). The constant K factor multiplier in the USACE calculation is 21,600 for an open-water blast instead of the 22,550 from the original Cole Expression. This factor is slightly less (~4%) than the original Cole. The decay factor (-1.13) used in the USACE modified equation remains the same as the original Cole Equation. To account for the confining effect of the concrete pier structure, a conservative K factor of 7,500 was used corresponding to multiplying USACE P_{pk} by a factor of 0.3472. With a minimum delay between of blast of 9 ms, the individual delays will be spaced sufficiently far in time to avoid addition of the peak pressures. In this case, the peak pressure is defined by that calculated for the largest charge weight of 35 pounds/delay. A BAS is specified in the Blast Plan. Based on the literature and recent results from similar projects, reductions in the pressure peak of 85% to 90% or more are expected. For determining P_{pk} in this analysis, a conservative reduction of 80% has been used. Based on values of confinement, BAS performance, and the “General Assumptions” above, the calculated peak pressures are expected to be conservative.

Estimation of SEL Values

Estimating the weighted SEL values for the different groups/species is a multiple step process. The first step is to estimate SEL values as a function of distance from the blast pressure versus time histories for each of the six charge weights as a function of distance.

The open-water equation used for this calculation was that modified by the USACE (1991) based on methods pioneered by Cole (1948). Pressure as a function of time is given by:

$$P(t) = P_{pk} e^{-\left(\frac{t-t_a}{\theta}\right)} \qquad (5)$$

where t_a is given as R/5,000 and θ is:

$$\theta = 6.0 \times 10^{-5} W^{1/3} (\lambda)^{0.18} \qquad (6)$$

Some of the time histories produced by these equations are shown in Figure 1 for varying distances from the blast. These calculations were then extended to distances out to 160,000 ft (48.8 km).

As discussed previously, there are other wave components that could be considered in the SEL estimation, including the surface relief wave, reflection from the bottom, and transmission through and re-radiation from the bottom. Little or no contribution is expected from the bottom based on its sedimentary nature and previous experiences from measuring noise from underwater pile driving in the area around Pier E3. The negative surface relief wave could be a factor in the SEL estimation. This wave could either increase or decrease the SEL depending on its arrival time relative to the direct wave. For small differences in arrival time, the surface relief will decrease the total SEL as a portion of the positive direct wave is negated by the addition of the negative surface relief wave. This is illustrated in Figure 2 for a blast and receptor depth of 30 ft (9 m) and a range of 1,000 ft (305 m). In this case, the surface relief wave essentially balances the direct wave so that the total SEL is within a few tenths of a decibel of the direct wave only. For closer distances and when the receptor and blast locations are near the bottom, the total SEL can become greater than the direct wave SEL, but only by less than 3 dB. However, whenever the source or receiver is near the surface, the direct wave SEL will be greater than the total SEL and can approach being 10 dB greater for distances beyond 1,000 ft (305 m). As a result, the surface relief wave is ignored in this analysis knowing that the surface relief wave would only tend to produce lower SEL values than the direct wave.

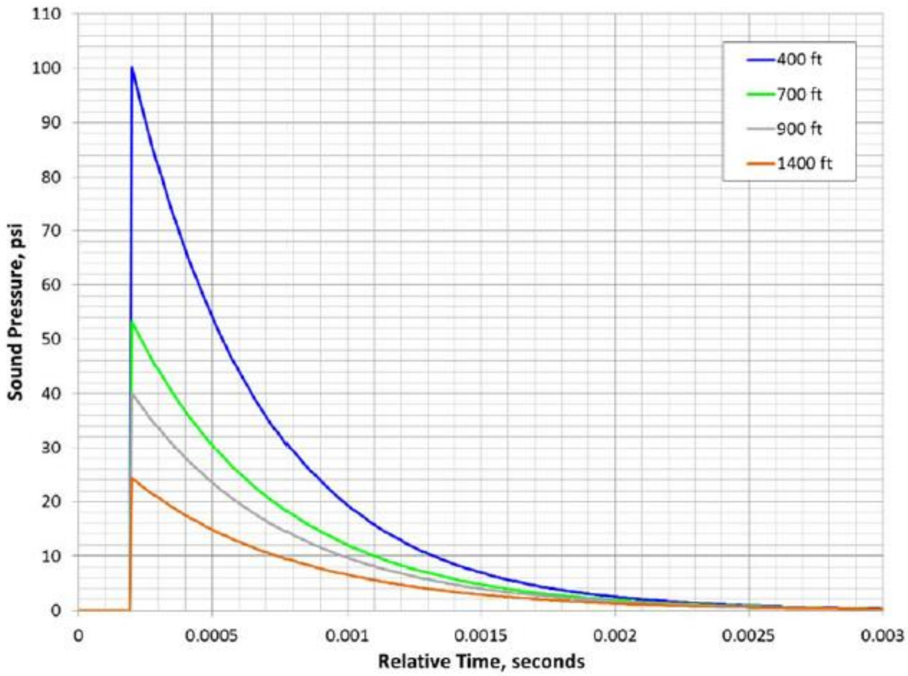

Figure 1. Blast wave forms vs. time relative the same arrival time calculated for different blast distances.

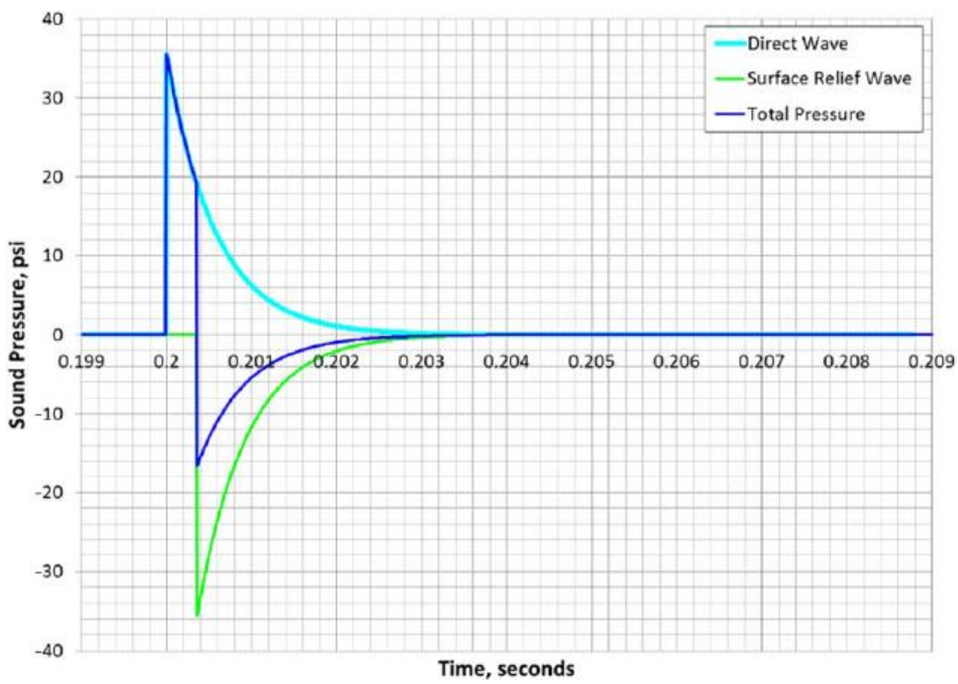

Figure 2. Total pressure vs. time history for combined direct and surface relief wave 1,000 ft from the blast with source and receiver 30 ft deep.

For each of the marine mammal groupings included in Table 1, specific filter shapes apply to each functional hearing group. To apply this weighting, the Fast Fourier Transform (FFT) was calculated for the time histories at each analysis distance. Each FFT was then filtered using the frequency weighted specified for each group. Filter factors were then determined for each distance by subtracting the filtered result from the unfiltered FFT data and determining the overall noise reduction in decibels. These filter factors were applied to the accumulated SEL determined for the entire blast event for each distance from the Pier.

The BAS of the Blast Plan will have an effect on the wave once a blast passes through it. In a research report by USACE in 1964, the performance of a BAS was examined in detail (USACE 1964). It has also been found that for an energy metric such as SEL, the reduction produced by the BAS was equal to or greater than the reduction of the peak pressure (USACE 1991; Rude 2002; Rude and Lee 2007; Rivey 2011). To estimate the reduction for SEL values due to the BAS proposed in the Blast Plan (CALTRANS 2015), SEL was reduced by 80%. Effectively, this was done by reducing the SEL by 20 Log (0.20), or 14 dB. Delays below the mudline, which will be located below the BAS, were also reduced by 80% based on an assumption that the outside pier walls here (which will not be removed) and Bay mud sediments will provide a similar level of attenuation. These SEL values and those without the BAS were then compared to the appropriate criteria for each marine mammal group. Because the calculation of SEL is based on the peak pressure, these estimates for the direct wave component are expected to be conservative for the same reasons as described for the peak pressures.

Estimation of Positive Impulse

To estimate positive impulse values, the expression originally developed by Cole for open water was used (Cole 1948). This expression includes only contributions from the direct wave neglecting any contribution from the surface relief, bottom reflected, and bottom transmitted consistent with the assumptions used to estimate SEL. In this case, impulse is given by:

$$I = 2.18 \times W^{1/3} \times \left(\frac{W^{1/3}}{R} \right)^{1.05} \qquad (7)$$

with the variables defined in Equation 4. The impulse can also equivalently be calculated from wave forms as shown in Figure 1. Equation 5 produces impulse values in psi-msec which were converted to Pa-sec by multiplying by 6.9 for comparison to the marine mammal criteria.

Unlike P_{pk} and SEL, no reduction by the BAS is assumed for the impulse calculation. The area under the $P(t)$ curve under goes little change after passing the BAS. The peak pressure is reduced as noted previously, however, since the $P(t)$ expands in duration, the area change is minimal. This behavior is well documented in the literature (Cole 1948; USACE 1964; USACE 1991; Rickman 2000). As discussed above, this is not the case for SEL which is determined by the area under the $P^2(t)$ curve.

4.1.3.3 Estimated Takes of Marine Mammals

The estimated distances (Table 3) to the marine mammal criteria for peak pressure, SEL, and impulse are based on established relationships between charge weight and distance from the literature. The estimated distances were determined assuming unconfined open water blasts from the original Cole equations or the Cole equations modified by USACE. The assumption of open water neglects several effects that could produce lower levels than estimated. These include no shielding by the pier structure prior a specific blast, confining of the individual delays in the holes drilled into the pier structure, and longer distances to individual blasts than assumed by closest distance between the pier and the receptor point. For SEL, the assumption of open water blasts neglects the surface relief wave which at longer distances from the pier, would tend to reduce the SEL due to interference with the direct wave. Although the estimated levels and distances may be conservative, there is sufficient uncertainty in the blast event and its propagation such that further, less conservative adjustments would not be appropriate.

Estimated exposure numbers are subsequently calculated based on modeled ensonified areas and marine mammal density information. However, since many marine mammals are expected to occur in groups, the estimated exposure numbers are adjusted upward by a factor of 2 to provide estimated take numbers. In addition, although modeling shows that no California sea lion would be exposure to noise levels that would result a take, its presence in the vicinity of SFOBB has been documented. Therefore, a take of 2 of California sea lion is assessed. A summary of estimated takes and exposures of marine mammals that could result from CALTRANS' Pier E3 controlled implosion is provided in Table 4. Further, with the monitoring and mitigation measures proposed in the IHA, there would be no Level A takes.

Table 3. Estimated distances to NMFS marine mammal explosion criteria for Level B harassment, Level A harassment, and mortality from the proposed Pier E3 implosion. A BAS with 80% efficiency in acoustic attenuation is assessed for the implosion. For thresholds with dual criteria, the larger distances (i.e., more conservative) are presented in bold and are used for take estimates.

Species	Level B Criteria		Level A Criteria			Mortality
	Behavioral Response	TTS Dual Criteria	PTS Dual Criteria	GI Track	Lung Injury	
Pacific Harbor Seal	9,700 ft (2,957 m)	**5,700 ft (1,737 m)** 440 ft (134 m)	**1,160 ft (354 m)** 70 ft (21 m)	35 ft (11 m)	450 ft (137 m)	205 ft (63 m)
California Sea Lion	800 ft (244 m)	470 ft (143 m) 440 ft (134 m)	**245 ft (75 m)** 97 ft (30 m)	35 ft (11 m)	450 ft (137 m)	205 ft (63 m)
Northern Elephant Seal	9,700 ft (2,957 m)	**5,700 ft (1,737 m)** 440 ft (134 m)	**1,160 ft (354 m)** 70 ft (21 m)	35 ft (11 m)	450 ft (137 m)	205 ft (63 m)
Harbor Porpoise	44,500 ft (13,564 m)	**26,500 ft (8,077 m)** 2,600 ft (792 m)	**5,800 ft (1,768 m)** 1,400 ft (427 m)	35 ft (11 m)	450 ft (137 m)	205 ft (63 m)

Table 4. Summary of the estimated takes and exposures (in parenthesis) of marine mammals to the Pire E3 implosion.

Species	Level B take		Level A take	Mortality	Population	% take population
	Behavioral	TTS				
Pacific harbor seal	12 (6)	6 (3)	0 (0)	0 (0)	30.196	0.06%
California sea lion	2 (0)	0 (0)	0 (0)	0 (0)	296,750	0.00%
Northern elephant seal	2 (1)	0 (0)	0 (0)	0 (0)	124,000	0.00%
Harbor porpoise	2 (1)	0 (0)	0 (0)	0 (0)	9,886	0.02%

4.2 Effects Of Alternative 2: No Action Alternative

Under the No Action Alternative, NMFS would not issue an IHA to CALTRANS to conduct Pier E3 demolition using controlled implosion. As a result, CALTRANS would not receive an exemption from the MMPA prohibitions against the take of marine mammals and would be in violation of the MMPA if take of marine mammals occurs from controlled implosion method to demolish the structure. However, alternatively, CALTRANS could use mechanical method to dismantle the Pier E3 structure of the original SFOBB. In this case, CALTRANS would still have to apply for an IHA to take marine mammals. As discussed previously, the use of mechanical method to dismantle the structure would require months of additional in-water work time, and would have more impacts on aquatic resources of the San Francisco Bay. These impacts are provided in NMFS 2003 EA and 2009 SEA, and are incorporated here by reference.

4.3 Cumulative Effects

Cumulative effects are defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-federal) or person undertakes such other actions" (40 CFR §1508.7). Cumulative impacts can result from individually minor but collectively significant actions that take place over a period of time. The analysis of cumulative effects from CALTRANS' proposed Pier E3, including air quality, noise and vibration, hazardous wastes, water quality, natural resources, and cultural resources, is provided in FHWA 2001 FEIS. The analysis on the proposed action, when added to other past, present, and reasonably foreseeable impacts has shown that CALTRANS' SFOBB construction activities are not expected to have significant cumulative effects on the environment. This information is incorporated here by reference.

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